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HOWARD ARNESON'S POOL-SWEEP

In 1958 Mr. Howard Arneson, rather fortuitously, came across an idea for a device to clean swimming pools automatically. To pursue this idea further he started a tiny company with $8,000 in 1960. By 1965 the device was in production and in 1969 his company had sales exceeding six million dollars. Mr. Arneson now heads the company he sold to Castle and Cooke Inc. for 9 million dollars in 1969.

 Written by Mr. Prem C. Garg under the direction of Professor H. O. Fuchs with support from the National Science Foundation. The assistance and cooperation of Mr. Howard Arneson and Mr. W. R. Reinbacher is gratefully acknowledged.

HOWARD ARNESON'S POOL-SWEEP

"Practically all the 40,000 Pool-Sweeps (trade name of the device) sold so far have been sold in California. We have yet to make a serious effort for markets outside California," says Mr. Arneson with a glow in his eyes, emphasizing that he is not day-dreaming. Not that day-dreaming is something unfamiliar to Arnie; for that matter in fact, pool-sweep has been the only "genuine break" he has had during a career extending over the past thirty years.

Too ambitious and independent-minded to work for anyone, he has been living off his 'own wits' for most of the time since his high school graduation in 1939. "Going to college was out of the question; my parents just couldn't afford it and I wasn't all that bright either to get some scholarship," recollects Arnie, "I used to get A's in the subjects I liked, but then there weren't too many of them," he adds with his characteristic smile. Mechanical things had a special fascination for Arnie and he often tinkered with appliances at home. Drawing was his favorite subject in school, and thanks to his high school training, he could read blue prints 'half way'. His interest in mechanical things was further reinforced during the Second World War in which he served as an Aviation Gunnery Instructor.

After the war he started a Skeet Trap Field in Vallejo, a small town in California.* However, he made little headway in this venture and after a couple of years sold the trap field to work as a sporting goods salesman. During the early fifties he sold TV sets for Sears and he was extremely successful in this. "From my earnings," he says, "they used to withhold as income tax more than what most other guys took home." This success, however, did not dampen his interest in mechanical things and working with a colleague, he invented a light for emergency vehicles. Highway officials showed quite a bit of interest in that and he became very enthusiastic about its prospects. When in 1951 someone offered

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*Himself a versatile sportsman, his love for sports is perhaps second only to that for 'mechanical things'. In addition to being a past California Trap Shooting Champion, he is an expert fisherman as well. Competing in races on water as well as on land are some of his other hobbies.

to invest in his venture he decided, contrary to the advice of all his colleagues, to quit Sears. "Most of them thought I was insane to leave a job like that," he remembers. During his three years involvement in this venture he did manage to sell these lights to a number of public services (among them the police forces of Washington, D. C., Kansas City and New Orleans), but he isn't sure if, on the whole, he managed to break even or not. "Aside from the financial aspect," he says,"the venture was an extremely educational experience. Before then I never realized the importance of having the right distributors with 'proper contacts' in selling a product like this." (Incidentally, he still isn't sorry for his decision to quit Sears. "If I had to make that decision all over again, I would quit again.")

Finding himself in an unprofitable concern, he gradually phased out of the emergency light business and spent the next four years producing and marketing fishing tackle.

"None of these ventures was a major disaster, but then neither were they a 'success'. I always had the feeling that I was going to do something better than what I was doing at that time." The opportunity to do that "something" came in a rather inconspicuous and accidental manner.

Sometime in early 1958 he was contacted by a San Rafael engineer named Andrew Pansini (Arnie doesn't remember the exact date). "Our contact was purely accidental. Mr. Pansini had happened to mention to a friend in Los Angeles that he was looking for someone who could help him in the development of a product based upon his ideas for a swimming pool cleaning device. This friend of his knew me pretty well and he suggested that my experience and aptitude for this kind of work could be very helpful to Mr. Pansini."

"Mr. Pansini felt that his idea, if successful, would completely revolutionize the irksome task of pool cleaning.*

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*As any pool owner would testify, the most irritating aspect of owning a swimming pool is the job of keeping it clean. The conventional methods include manual brushing of sides and bottom as well as vacuum cleaning to remove the foreign matter. For those who neither like the nuisance of cleaning their pools themselves nor the sight of disgruntled teenage sons, there are pool service companies. For a monthly charge of about 30 dollars they provide 2 cleanings a week, each of about 15 minutes duration.

His idea was rather simple. Many people refill their swimming pools by letting garden hoses run into the pool. When you take those hoses out, you always find the area where they discharged water to be nice and clean. Now if you were to take a hose and try to clean the pool by just walking around it, you would never get it cleaned because you would just be chasing dirt from one corner to another -- or perhaps if someone had the patience and the time he could clean it, but that certainly is not the best way to do it. Mr. Pansini was thinking of carrying this idea further: he wanted to simulate this action automatically by directing high pressure water jets on the walls and the floor of the pool in some organized fashion.

"Mr. Pansini's approach was to have some kind of platform floating in the pool and connected to a high pressure water source. A small part of the incoming water was to be used for propelling the platform, while the rest was to clean the bottom and sides of the pool. Obviously there were two major design problems involved: first to feed the high pressure water to the mobile platform and second to propel the platform in some desirable fashion. Of course nobody knew what such a desirable pattern might be. We exchanged our ideas on these problems and working on those ideas we had a crude model fabricated within a few days time. Mr. Pansini was impressed with my work and asked me to continue helping him in the development."

In the same year Mr. Pansini filed a patent application for a jet propelled cleaning device. (The patent was subsequently granted in 1962.) Exhibit 1, an excerpt from his patent, shows schematically the main features of his system. The device was extremely simple in construction. It consisted of a stationary steel pipe AB supported on the surface of the pool and connected to a high pressure water source (at about 40 psi). Another steel pipe CD was connected to AB through a swivel joint. The swivel joint permitted the pipe CD to rotate about vertical axis BC, without any leakage. A flexible cleaning hose EF was connected at the other end of CD, through a second swivel joint. At the free end F of hose EF was attached a nozzle through which the cleaning jets were discharged. There was also a secondary nozzle at joint DE. Reaction from the secondary jet rotated pipe CD, along with hose EF, about BC. The reaction from the main nozzle at F made the hose EF execute a wavy pattern, spraying high pressure water jets over the bottom and sides of the pool. The agitated

dirt gradually gravitated towards the main drain where it was aspirated by the pool filter system. A specially designed plate P placed over the main drain induced currents in the water around the main drain to assist in collecting the dirt.

"I kept fooling around with various ideas to improve the crude device for about a year. My interest in the product at that time was rather peripheral, however. At that time I was sold on the idea of some hose coupling devices and was trying to get patents on those. In fact during that period I didn't really take the device very seriously; it seemed more of a novelty than a practical product. Mr. Pansini was extremely pleased with my work, however, and in 1959 he asked me to work for him full time on the development of this device. In addition to the regular salary, he offered me a 10% interest in the patents he might get on this product."

"It didn't take us long to realize that the original device needed many modifications and improvements. With the kind of model Mr. Pansini had in his patent, it was extremely difficult to cover the whole pool; especially if the pool happened to be of an odd shape, say 'L' shaped or a narrow rectangle where the pipe CD could cover only a small part by its rotation. To get better coverage we made substantial changes. Instead of keeping pipe AB stationary, it was made to oscillate. Also a tripping mechanism was introduced to diversify the pattern of movement of the cleaner hose. By late 1959 we had a fairly good workable prototype; in fact, we sold some of these prototypes to some overly enthusiastic customers."

"In 1960 Mr. Pansini decided to sell the rights to commercialize this product to Anthony Pools, a large pool building company in Los Angeles. In the contract he offered to make arrangements so that I could get a license from Anthony Pools for exclusive rights to Northern California."

"I had to make a big decision. While the product did seem to hold a lot of promise, there was no guarantee of anything.* In fact by that time the initial enthusiasm

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*In the United States there were about one million pools in 1969 and over 80,000 new ones being built every year.

of some of our earliest customers had started to wane; they still felt that the device was great but added that it was rather cumbersome to have in the pool. It appeared to me that any large scale commercialization of this product would require nothing short of a complete re-design. Transforming the excellent idea of a jet propelled cleaning device into a functional product undoubtedly held a lot of challenge and excitement and possibly a fortune too. I felt that even though I could keep working on the development as a 'diversion', I would have to give my full attention to this product to do a good job. By accepting Mr. Pansini's offer I could continue working on the development while at the same time supporting myself by selling the old models. Consequently in spite of the long range financial uncertainties involved, I decided to accept the offer."

Having made his plans, Arnie discussed them with his wife Eva. "Notwithstanding my previous adventures she was very encouraging in her response and showed full faith in my plans. She was working for the Board of Education at that time. She quit that job and decided to join me in this venture."

"Over the years we had been able to save some money. Eva was also able to get some money out of her retirement fund, and we were able to raise about $8,000 to start with."

It was a modest beginning for Arneson. He decided to concentrate on marketing the device based upon the existing model, at that stage. He rented a small basement shop. Most of the parts for the device were available on the market and needed only assembling. However there were some which he could not get. "Having a workshop of my own was just not feasible at that time; so I arranged to have the parts made by a man who ran a small workshop and did odd jobs for a variety of customers."

"Apart from Eva's assistance I was taking care of everything myself. One day I would be out soliciting new customers; the next day I would be busy with installation or maintenance or something else. This total involvement proved very useful later on. On the one hand I became aware of the product's strong points and weak points as regards manufacturing, maintenance, assembly and installation, etc.; on the other hand from the way my customers reacted to it I could look at it from their point of view.

This insight avoided numerous pitfalls which so often occur when someone tries to design something without knowing what he really needs to have.

"In spite of all my attempts to economize, I soon realized that $8,000 wouldn't go too far. It wasn't long before all the money was tied up and we were living on petty cash. Things weren't going badly, however, on paper at least; during the first nine months we sold about 200 of these cleaners and showed a net profit of $36,000. This was good enough to help us get loans from commercial banks."

His main opportunity, however, came in 1961 when Anthony Pools failed to keep up their contract with Mr. Pansini and their license was withdrawn. "Not only did they fail on promised sales figures, but they also didn't do anything to further develop the product. They did make some changes, but they were moving backwards; they were trying things we had already discarded." Mr. Arneson bought the license himself from Mr. Pansini and now had the exclusive rights on the jet propelled cleaning devices. (To complete the full cycle, Mr. Arneson now sub-licensed Anthony Pools to make these cleaners for their own use.)

Over a year's association with the device had confirmed Arnie's belief that while the basic idea was brilliant, the product as it was at that time left much to be desired. "It was just a mechanical monster. The unshapely steel pipes lying in the pool were not only an eyesore but were also a potential hazard to swimmers. They needed a carton over 15' long for shipping and every pool required different sizes and configurations of these pipes. The installation was so involved that I had to do all the selling myself; you just couldn't teach anyone the way to install it. It wasn't something you could sell wholesale or sell by mail. The last and most important drawback was the fact that while in some pools it worked beautifully, in others it would simply chase the dirt from one corner to the other. Evidently we needed something which would be foolproof in operation, easy to install and ship and would not obstruct the use of the swimming pool.

"I felt that there was really no reason for those steel pipes to be there at all. Their only function was to supply the cleaning hose with water and to move it around the pool. I felt that it should be possible to accomplish this without using the steel pipes."

In an attempt to eliminate the steel pipes Arnie replaced them with a flexible hose to which the cleaning hoses were connected as previously (see Exhibit 2, note there are two cleaning hoses instead of one). The propulsion was again achieved by the reaction from the jet at the end of the flexible (feeder) hose. While the introduction of the flexible hose removed many of the shortcomings of the first model, it did create some new problems. There were leakage problems due to puncturing of the floating hose and also the fact that the device drifted aimlessly on windy days. Even without the winds, there was much less control over the pattern of movement of the cleaning hoses. Consequently, in some pools it worked and in some others it just didn't. So it turned out that this solution, though better than the previous one, was still far from satisfactory.

In late 1963 Arnie first conceived of the product in its present form. "Really it is an offshoot of the floating hose concept. Since the main trouble with the floating hose model was the lack of control over the propulsive thrust from the drive jet, I felt that what we needed was some mechanism through which we could control the magnitude and direction of the drive jet thrust, at will. Further thought on these lines indicated that this should not be very difficult to do, e.g., a system of valves operated in some periodic fashion could control the flow through the drive jet nozzle thus controlling the thrust. The valves could be operated by using part of the high pressure water energy, say by running a small turbine wheel in the mobile platform and using its rotation to run the valves. The more I thought about it, the more convinced I became that this approach was workable. In my mind I began to see the whole thing very clearly. I could see the water wheel turning; I could see the gears meshing with each other; I could see the valves opening and closing. I had the functional design pretty well figured out. But that's not quite the same thing as the actual design; I still had to make numerous decisions, e.g. the pattern for the movement of the hoses, the thrust combinations to be used or even the duration of the valve cycle to get best results. Admittedly, I didn't have the training to calculate all those things but I don't think mathematics would have helped anyway. There were just so many variables involved that an engineer could have spent months working on a big computer just to prove that such a thing won't even work. I think my ignorance was an

advantage in this case. Since I didn't know what was there in the books, I was able to work with freedom and an open mind.

"I decided not to bother about the details; I thought I could let someone else worry about them later on. Instead, I concentrated on verifying if my approach was workable. I tried to keep my design simple using standard parts as far as I could. Often I used parts scavenged from junk; I remember some of the gears I used in the early models were reclaimed from discarded lawn sprinklers.

Exhibit 3 shows a photograph of one of the earliest models Arnie made to check his ideas regarding the propulsion mechanism. Though this model was far off from the final product envisioned by Arnie, it worked well enough to assure him of the soundness of his approach.

"Developing these ideas further was important but at the same time I could not afford to have a decline in the sale of the floating hose cleaners -- profits from them were the only source of income I had at that time. So during the daytime I would be out selling or installing those cleaners. Whenever some new idea came to my mind I would scribble it down on some scratch paper. Late in the evening I would meet the machinist and we would make parts based upon my 'blue prints' and then I would be out trying those ideas at some neighbor's swimming pool.*

"Progress was slow. While it didn't take long to get the basic ideas about the functional design, to come up with something which actually worked the way I wanted it to work was quite another story. The actual design took thousands of hours of just standing around the pools and watching the device move around and figuring out ways to make it do better. There were hundreds of changes in the design. A design would work beautifully in one pool, you take it to another pool and it would start doing all sorts

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*Since Mr. Arneson did not have a swimming pool of his own during those days, he had to work around the pools of his friends and neighbors. "To a certain extent this was a handicap; I often had to work at odd hours so as not to interfere with normal usage. In the long run, however, it proved a blessing. If I had had my own pool, I would have been wedded to one pool. Working in pools of all kinds of different shapes and sizes resulted in a product which worked perfectly in every pool."

of crazy things. During those days it was nothing for me to come home at four in the morning after trying my ideas the whole night. Often the machinist would complete some part at midnight and then I wouldn't have the patience to wait 'til the next morning. Mostly it was trial and error. At times it was very depressing; however I never got depressed enough to think of leaving it. It never once occurred to me that I wouldn't succeed."

Gradually Arnie's never-say-die approach began to pay off. Within a period of six months he had a prototype which satisfied most of the stringent requirements he had set for the device. Exhibit 4 shows schematically the working of such a system. Exhibit 5 gives the details of the Pool-Sweep head (Item 7, Exhibit 4), the unit responsible for transporting the cleaning hoses into the various parts of the pool. As shown in Exhibit 4, high pressure water is fed into the head through the feeder hose. There it drives a turbine wheel which in turn rotates the main shaft as well as the drive jet shaft, through worm gear reductions (see Exhibit 5). There is a 25:1 reduction from the turbine wheel to the main shaft and a further 100:1 reduction from the main shaft to the drive jet shaft. During operation the drive jet shaft completes one revolution about every 4 minutes. The water, after driving the turbine wheel, leaves the head in the form of five different jets as indicated below:

i) Two jets through the cleaning hoses for cleaning the sides and bottom of the pool.
ii) Two propulsion jets through the drive jet shaft for the backward and forward propulsion of the unit in the pool.
iii) A small jet through the top of the main shaft to clean the above water tiles as well as to skim the pool water surface so as to settle down any floating dirt particles.

Flow is continuous through the cleaning jets but a valve mounted on the drive jet shaft controls the flow through the propulsion jets. Both the forward and backward propulsion jets rotate with the drive jet shaft. However while the backward jet nozzle is concentric with the shaft axis, the forward jet nozzle is tilted by about 15° from the drive jet shaft axis. The backward jet is operated for a small part of the cycle only (about 1/12). The forward jet operates all the time except when the

backward jet is working. As a reaction to the propulsion jets, the head, along with the hoses connected to it, moves around in the pool. While the path followed by the unit during any cycle of the drive jet shaft is predictable with reasonable accuracy, over a period of a couple of hours there is enough variation in the motion so as to cover practically every spot in the pool.

In analysing the pattern of the head movement, the first thing to be noticed is the fact that since the forward jet nozzle is inclined to the drive jet shaft axis, the forward thrust will vary in direction all the time. Consequently, the positioning of the backward jet vis-a-vis the forward jet is very important in determining the pattern of motion. Looking from the rear of the head the drive shaft rotates in a clockwise direction. To keep track of the various phases in the cycle, the whole cycle could be divided into twelve equal parts, thus establishing a correspondence between the forward jet nozzle and the hour hand of a clock. As an example assume that the backward jet operates from 9 to 10 o'clock (it's possible to change this setting). The resulting pattern of movement starting from some arbitrary location in the pool and 12 o'clock position of the jet is shown in Exhibit 6. From 12 to 6 o'clock the thrust from forward jet in addition to moving the head forward pushes it towards the wall of the pool as well. Depending upon the starting location, the head may contact the wall at some time during this part of the cycle. After contacting the wall, it would continue to move along the wall 'til 6 o'clock. The traction wheel attached to the main shaft presses against the wall (due to side thrust from the forward jet) and provides part of the traction. At 6 o'clock the direction of the side thrust component is reversed and the unit starts moving away from the wall. At 9 o'clock the forward jet closes and the unit starts moving backward under the influence of the backward jet. (This was introduced to eliminate the possibility of the unit getting stalled in some corner of the staircase during forward motion. However, this also provides greater diversity in the pattern of motion.) At 10 o'clock the forward jet will start again taking it forward 'til at 12 o'clock the same thing starts all over again from some different point. Over a period of time the unit spends about three quarters of the time moving close to the walls and the rest in crossing over the pool. The cleaning hoses trail the head in a somewhat lazy manner, shifting the dirt towards the main drain. While the isolated effect of any

one sweep may be good or bad or probably both good and bad (in terms of moving the dirt towards the main drain), the cumulative effect of, say 100 cycles, results in all the dirt being moved to the main drain.

It is impossible to list all the design problems Arnie faced during the development period. The one mentioned below, known in the company as "Tangling Hose Problem" may give some idea of their nature and magnitude.

This problem was among the earliest to be encountered and last to be solved. As the name implies the problem concerned the tangling of the feeder and cleaning hoses with each other. It is obvious that every time the head circled around the pool once, the feeder hose would get twisted and unless the unit could get rid of the twist it would quickly jam up. This meant that there had to be a joint in the feeder hose which would turn freely but at the same time would be leak proof against 40-50 psi pressure. A conventional joint with an O-ring didn't work; it had too much friction. In looking for a solution to this problem Arnie came up with a very simple and inexpensive swivel joint. (The joint proved to be patentable in itself.)

To his dismay, however, Arnie found that in many pools the hoses got tangled even with the swivel joint. Evidently there were many other factors involved, e.g.,

- -Length of the feeder hose vis-a-vis the pool size and shape
- -Pressure in the pool sweep head (affects the drive jet thrust)
- -Material of the hoses
- -Temperature of the pool water.
- -Position of floats on the feeder hose.

The importance of these and some other factors was realized by Mr. Arneson rather early in the development by his hit and miss approach. Working around these parameters he managed to design his system so that it worked most of the time im most pools. During the early years of marketing it worked out satisfactorily; there were complaints but not too many. Later when the number of units in operation increased, the number of complaints rose accordingly. By 1969 they were getting as many as 30 complaints a day (there were around 25,000 units in operation). So in 1969 renewed efforts were made to solve

the problem. At that time the set up shown in Exhibit 7 was found, rather accidentally, which all but eliminated the problem. The only essential difference between this set-up and the previous set-ups is the weight "w" (≈4 lbs.) mounted on the feeder hose.

By late 1964 Arnie was more or less through with the technical problems and the prototype was refined enough to start thinking in terms of production. "'Til then I had given very little thought to the production aspect. For the prototypes, we had been machining most of the components from thick plastic sheets and gluing them together; you can't do that in mass production. Also there was the need for selecting appropriate materials for various components. Practical considerations limited the choice to plastics for most components, however there still was the need for picking up the proper ones from an endless variety of available plastics. It was here that assistance from Jupiter Engineering Inc., a plastic injection molding company in Menlo Park, California, came in handy to us. Mr. Reinbacher, Jupiter's President, had just started his own company after working for a long time with DuPont and was looking for clients. The Pool-Sweep provided Jupiter with an ideal opportunity. On the one hand it had enough complexities to let them establish a reputation for the company; on the other it had a big market potential. The arrangement with Jupiter proved good for us as well; we were able to get their exclusive attention as they did not have very many clients at that time." The whole unit was redesigned by Jupiter after taking into consideration the manufacturing, materials and aesthetic aspects. Exhibit 8 shows the arrangement of the major components in the redesigned system. In Exhibit 9 is shown an exploded view of the pool-sweep head, the "brain" of the system.

"In about six months time Jupiter Engineering provided us with the molded specimens for testing and evaluation. Most of the components did very well during the tests; the gear housing (see Exhibit 8), however, proved to be troublesome. It just couldn't withstand the pressure. Either it would burst under pressure or there would be such large deformations that the gears would get out of alignment and the whole unit would get stalled. Naturally enough 'increase the thickness' was my immediate reaction; Mr. Reinbacher felt, however, that this wouldn't be of much help - the housing was already close to 'critical thickness; and any further increase would have resulted

in excessive molded-in stresses. To make the housing stronger, Jupiter changed the mold to add ribs to the housing; even this, however, did not solve the problem. At one stage it appeared to be a hopeless situation. Then Mr. Reinbacher suggested trying some other plastic. Luckily they were able to find a material which could be used with the old mold. The switching in materials proved to be effective and the crisis was averted. There were some other troubles too, but all of them were solved and we were ready to sell these units during the summer of 1965.

"From that time on, things have just mushroomed. We had sales of about half a million dollars during the first year and since then they have been doubling every year. The same thing happened with the number of our employees; 20 was a big number at one time and then all of a sudden I found myself with over 200 people to manage. This has certainly put some strains on the organization. Often there is lack of co-ordination between various departments. Sometimes we feel that we have too much paper flow and at other times we feel that we have too little. Also, so far it has been too much of a one man show. There has been lack of strong leadership in various departments, which primarily is my fault since I didn't delegate authority to other people."

Arnie isn't overly worried with these problems. "We are just suffering growing pains. Normally, if your sales increase 10% every year, your organization will grow accordingly. But when the sales get doubled every year you just have to live with these problems."

Reflecting back on the past Arnie feels that his success was due to a rather unique combination. "I was personally involved with the design while at the same time I was in touch with the customers. I have always been successful as a salesman. I could talk to people and sell." Talking about his sales policy, Arnie feels that the most important thing in selling is that you must have something to sell and further if you can convince your customer that you are not trying to take advantage of him, you are a good salesman." "Not a small part of my success was due to the fact that never for once did I give my customers a chance to complain. I would rather let my customers take advantage of me than let anybody in the organization take advantage of them by not doing his job properly."

Interestingly, Arnie feels that a big factor in his success during the development stages was the fact that he never had any problems with his machinist. "He made what I wanted. He was happy if it worked but it wasn't 'I told you so' if it did not. He never had any opinions of his own. Only one of us did the thinking and we thus eliminated many fruitless arguments." (Later Mr. Arneson bought all his equipment and engaged him as his shop supervisor.)

The exceptional success of the product hasn't closed Arnie's mind to the possibilities of further improvement. Neither has his interest in mechanical things been diminished by the organizational responsibilities. Often he still attends to the service calls himself. The disbelieving look on the startled faces of his customers has to be seen to be believed when a balding, medium statured man dressed in a sport shirt rings the door bell and introduces himself, "I am Mr. Arneson. I am here to attend to . . ."

LIST OF EXHIBITS

May 1, 1962 A. L. PANSINI 3,032,044

AUTOMATIC SWIMMING POOL CLEANER

Filed May 12, 1958 3 Sheets-Sheet 1

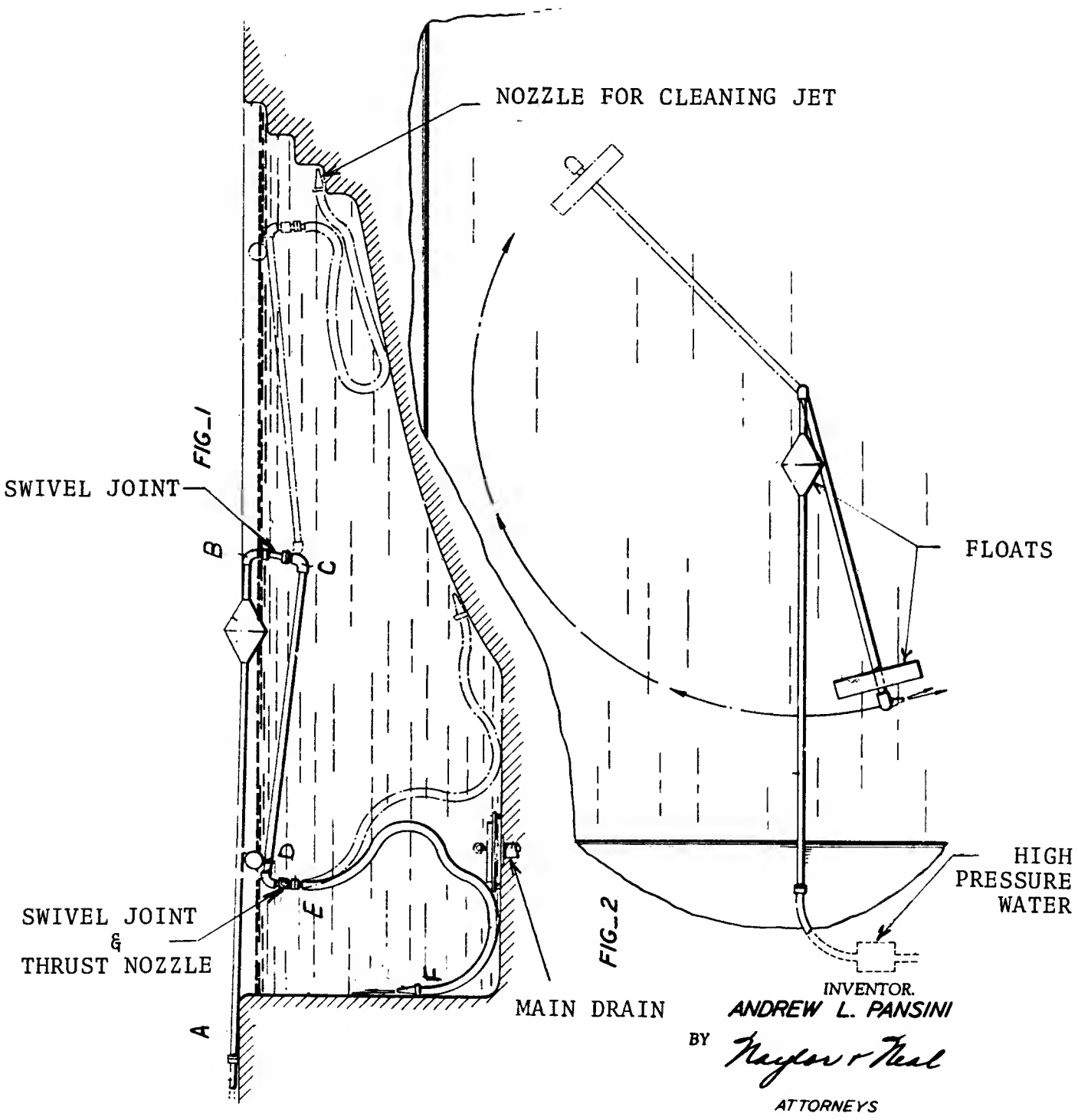


EXHIBIT 1

Schematic of Mr. Pansini's Pool-Sweep

How it works

1. Automatic timer turns pump on.

2. Filtered water from pool filter system is drawn into pump.

3. Pump boosts water at 60 lbs. (shut off pressure) to deck stand.

4. Water passes through deck stand on pool edge (pressure gauge and regulator valve enable pool owner to set cleaning pattern and speed of pool sweep).

5. Ribbed floating hose with pressure chamber inside air chamber carries water to floating cleaning head.

6. Some water flows through skimmer jet and driving jet—the latter transports cleaning hose about pool in systematic patterns.

7. Main portion of water flows through cleaning hoses and out jets at hose ends.

8. Jets blast dirt out of pool's pores and drives hoses about pool bottom and sides.

9. Loose dirt and debris are washed into main drain and into pool filtering system.

10. Leaf trap catches and holds larger dirt particles and leaves (may be lifted out by means of pool pole for emptying).

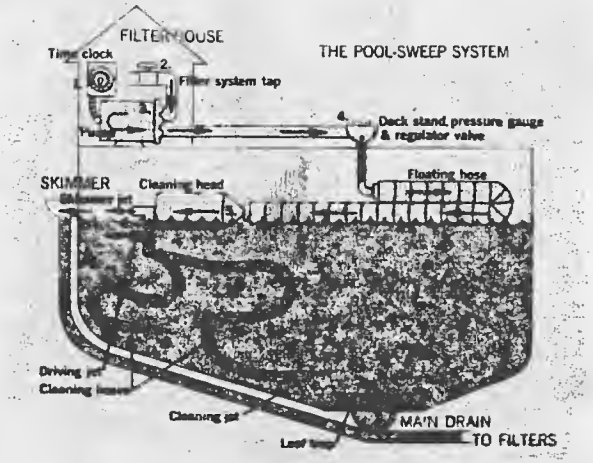


EXHIBIT 2
Mr. Arneson's Floating Hose Pool-Sweep System

ECL 146

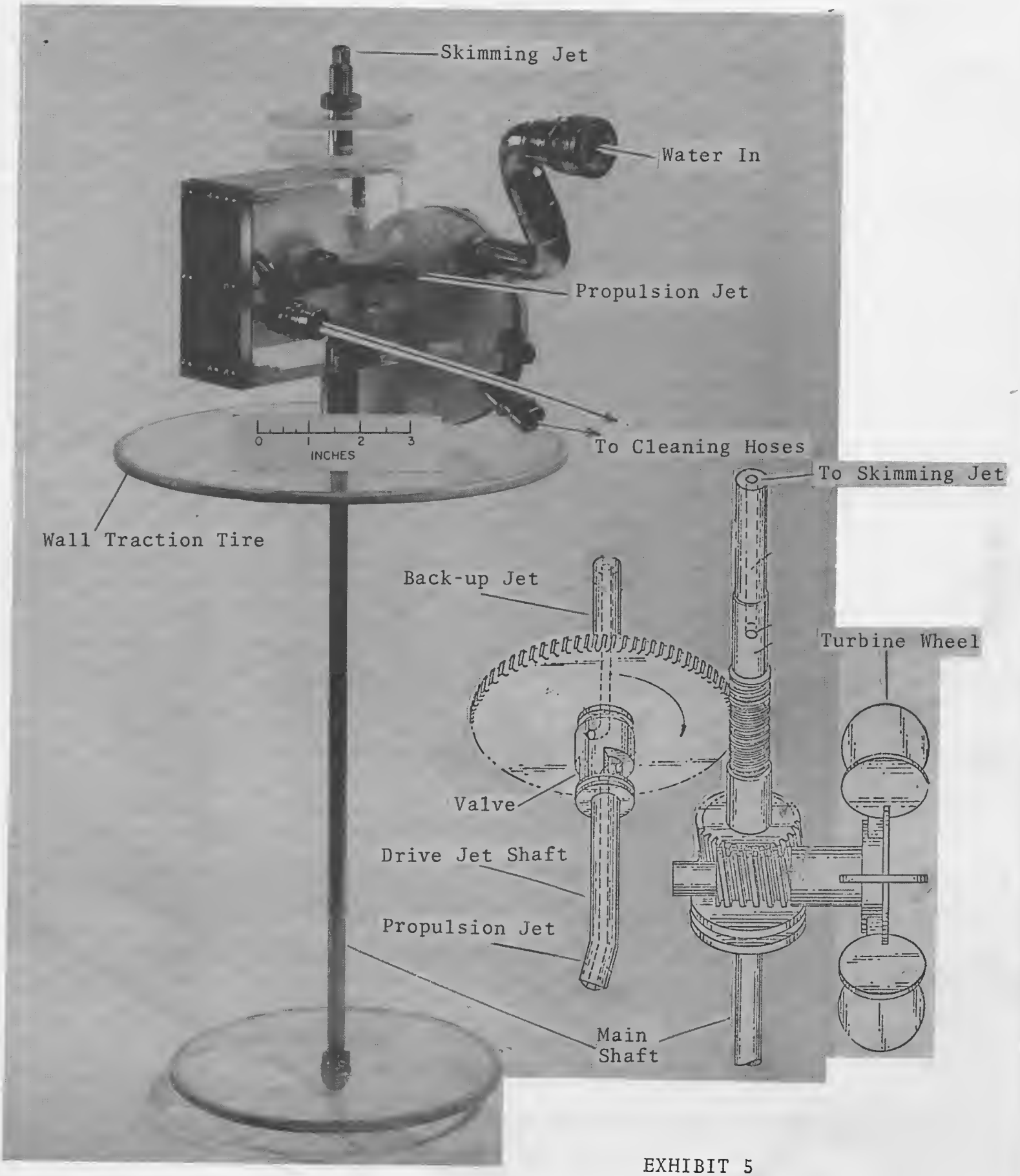
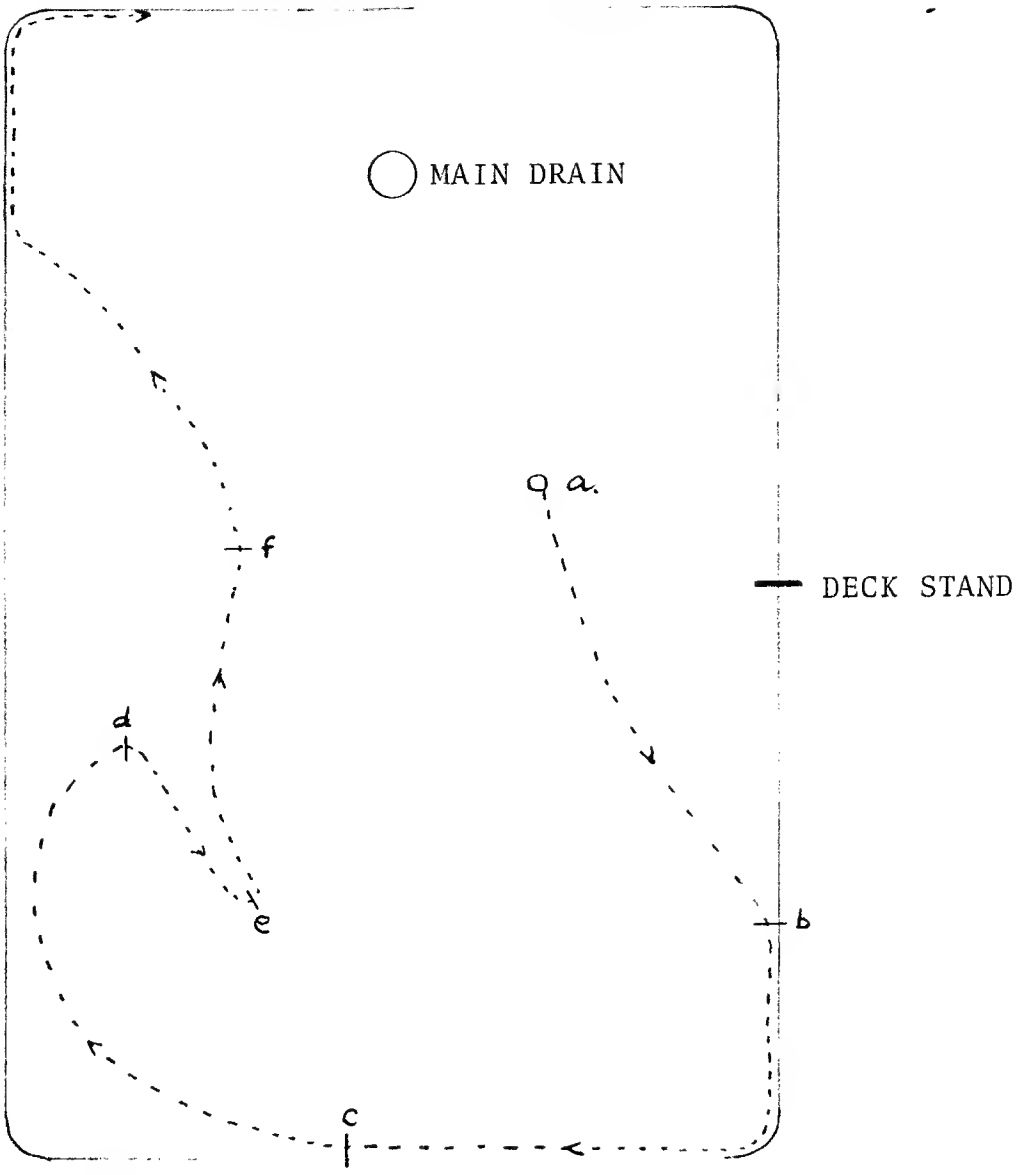


EXHIBIT 5
Details of Pool-Sweep Head



a) starting position of the head

a-b-c) path followed between 0-6 o'clock

c-d) 6-9 o'clock, head moving away from wall

d-e) 9-10 o'clock, backup

e-f) 10-12 o'clock

f) starting position for the next cycle

EXHIBIT 6. Movement pattern of Pool-Sweep Head

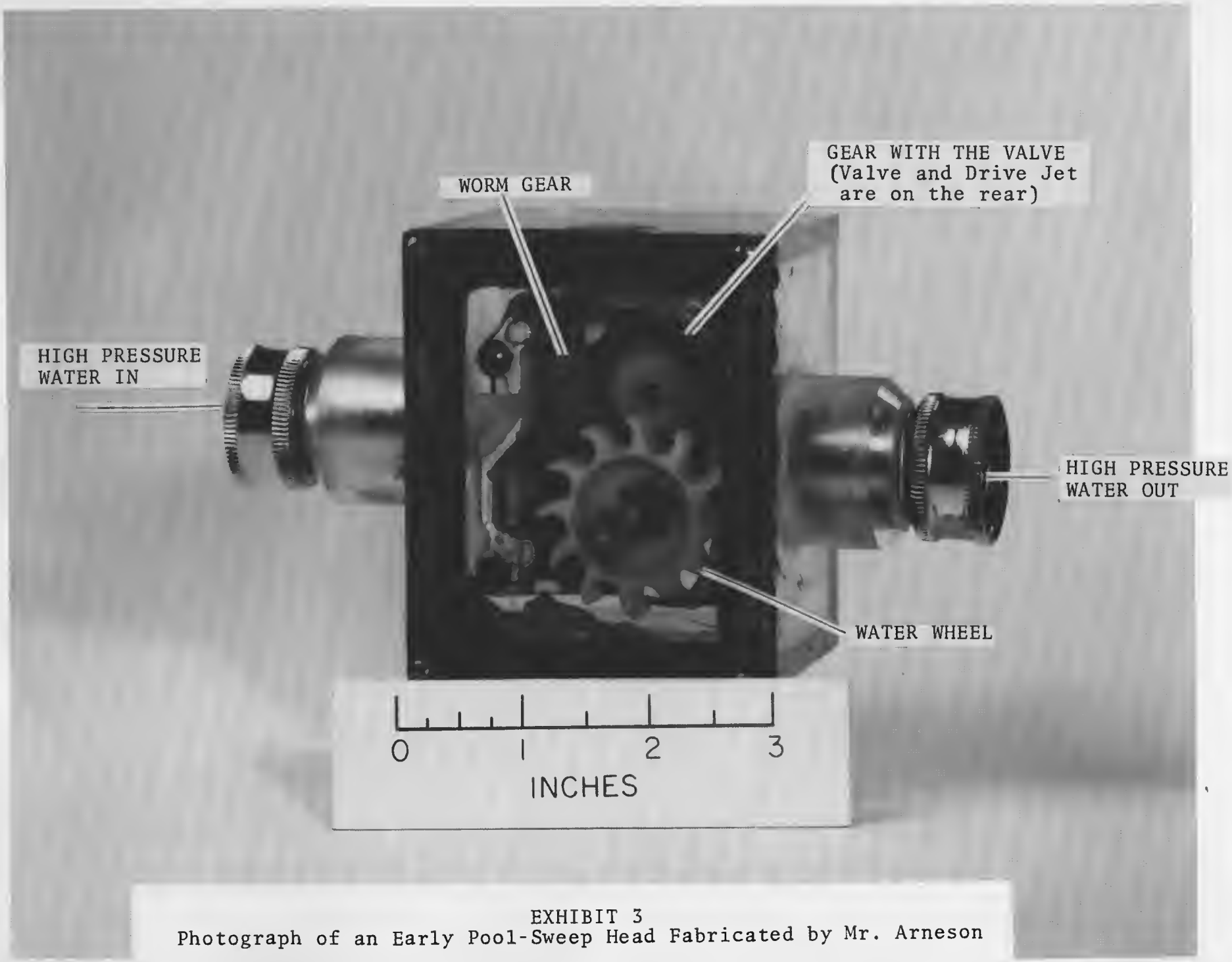


EXHIBIT 3
Photograph of an Early Pool-Sweep Head Fabricated by Mr. Arneson

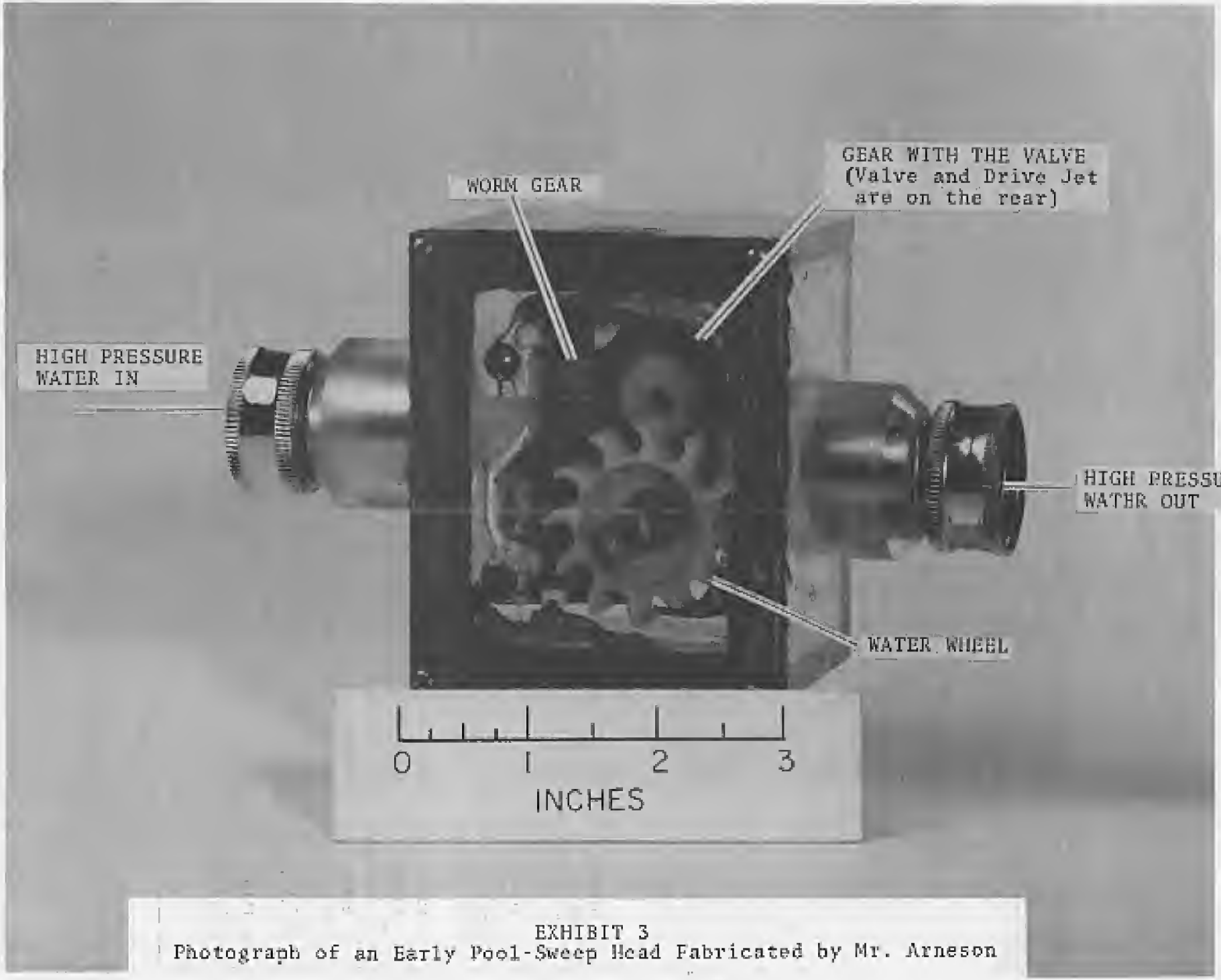
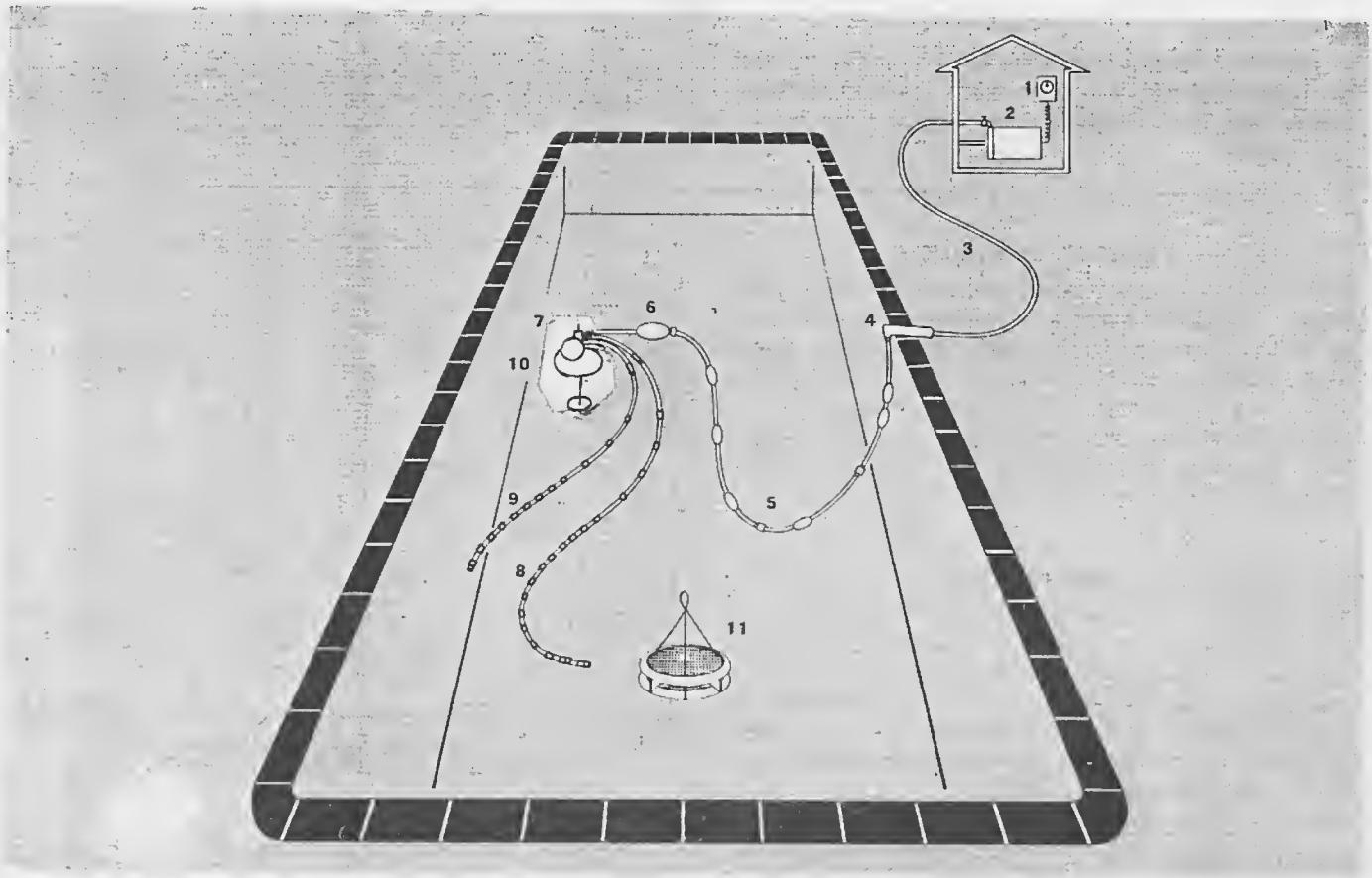


EXHIBIT 3
Photograph of an Early Pool-Sweep Head Fabricated by Mr. Arneson



NOMENCLATURE AND ELEMENTS OF POOL-SWEEP SYSTEM

1. AUTOMATIC TIMER (Optional, additional charge)
Separate time clock, installed when desired, to provide automatic turning on and off.

2. BOOSTER PUMP
Special pump installed to increase water pressure to approximately 50 lbs. working pressure for proper operation of POOL-SWEEP system.

3. SUPPLY HOSE (For existing pool)
Heavy flexible hose (in some installations, may be buried pipe) which carries water from booster pump to deck stand. (Not included due to variety of individual requirements.)

4. DECK STAND (For existing pool)
Designed to transfer water from supply hose to feeder hose, and portable for placement at desired position at pool coping.
Note: In new pools, a buried pipe and suitable wall fitting are provided to attach feeder hose.

5. FEEDER HOSE
Water supply hose which extends from deck stand or wall fitting to floating POOL-SWEEP.

6. FLOAT ARM
Special floating device designed to keep POOL-SWEEP in vertical position and aid in floatation of hoses.

7. POOL-SWEEP *HEAD*
Basic unit designed to float on water and transport cleaning hoses into every portion of pool to be cleaned.

8. FLOOR HOSE
Longer of the two sweep hoses, whose principal function is the cleaning of the pool's floor.

9. WALL HOSE
Shorter of the two cleaning hoses, whose principal function is the cleaning of the pool walls.

10. HOUSING BUMPER
Special bumper, which keeps POOL-SWEEP on desired tracking path around pool and steps.

11. LEAF TRAP
Special screen unit designed to catch leaves and other large objects as dirt is swept down drain.

EXHIBIT 4

Schematic of Mr. Arneson's Pool-Sweep System

FEEDER HOSE

CORRECT LENGTH OF FEEDER HOSE

The *feeder* hose carries water under pressure from the deck stand, or wall fitting, as the case may be, to the cleaner head. The deck stand (D28) or wall fitting (W10) should be positioned at the middle of a long pool side. If a wall fitting is used, it should be located below the tiles.

The feeder hose comes in three sections: a 6 ft. length of hose with two feeder hose weights (w) attached that connects to the deck stand or wall fitting; a 10 ft. length which is usually shortened, depending on the size of the pool; a 16 ft. length with three floats, A, B, and C attached. The weights on the 6 ft. section and the floats on the 16 ft. section are properly installed at the factory.

To determine the proper length, temporarily connect the entire hose and fill it with water by connecting it to the deck stand or wall fitting and turning on the pump for a few seconds. Walk the free end of the hose to the farthest corner of the pool from the deck stand. With the hose in a natural working position (Fig. 8B), there should be 3 feet of hose beyond the water's edge. The feeder hose will usually need to be shortened. Cut the excess from the 10 ft. middle section. For example, if you have 5 feet of feeder hose beyond the water's edge, then 2 feet must be cut from the 10 ft. middle section.

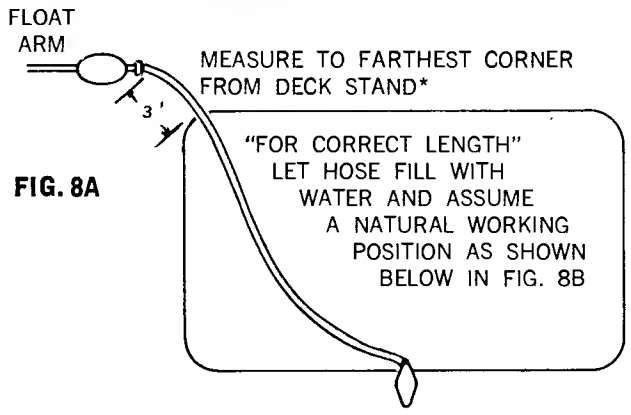


FIG. 8A

PLACE DECK STAND IN THE *MIDDLE* OF POOL SIDE

*If pool has odd shape make sure that you measure to corner of pool furthest away from deck stand location.

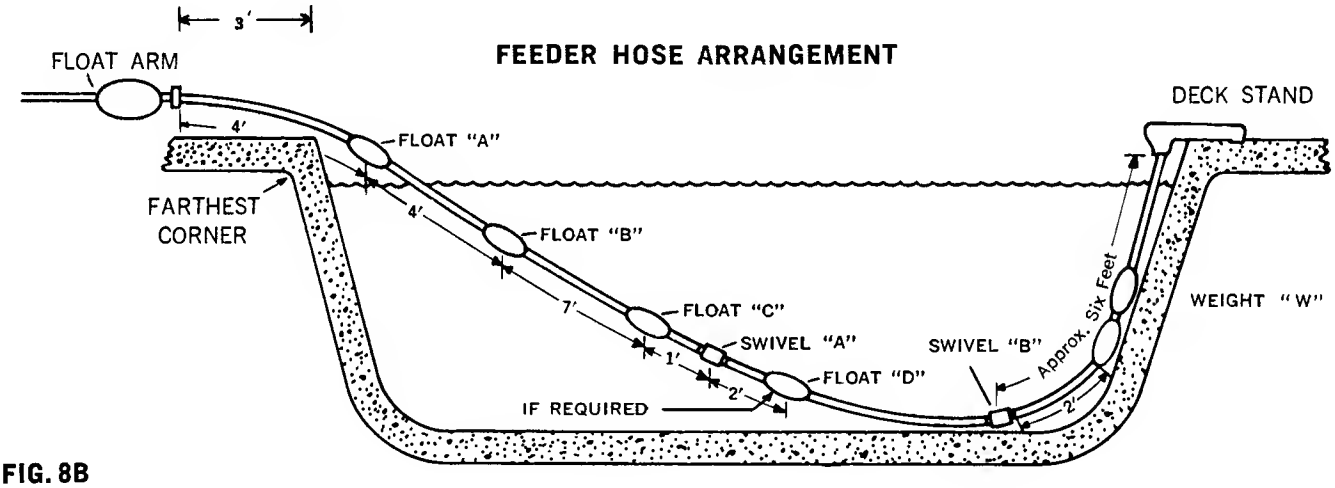


FIG. 8B

Extra float

The float on the hose extension (the 10 ft. middle section), should be positioned as follows:

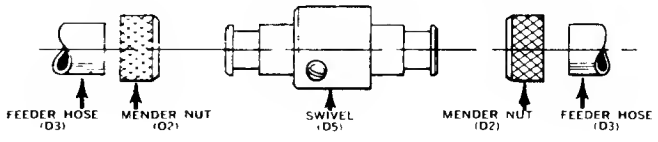
(1) If the extension is 6 ft. or less, *no* float is added, but if more than 6 ft. then position one float, "D," two feet from swivel "A" as seen above.

(2) Rarely will more than 10 ft. of extension hose be required but the factory will provide up to 16 ft. lengths if needed. If more than 10 ft. is used, a second float (not shown above) will be needed and should be positioned on the extension hose 5 ft. from float "D."

In order to connect to the swivel connector (D5) proceed as follows: Take the ⅝" mender nut (D2) that comes with the box of hoses, slip it on the swivel connector with the beveled edge of the nut facing toward the middle of the connector.

Push the free hose end over the swivel connector and thread the mender nut over the hose end tightly. (See illustration Detail C.)

DETAIL C—TYPICAL SWIVEL CONNECTION



Wetting the quick-disconnect coupling for easier installation, attach the feeder hose to the deck stand (D28), or wall fitting (W5), depending on the type of installation. Again, wetting the quick-disconnect coupling, connect the other end of the feeder hose assembly to the float arm assembly (F3).

EXHIBIT 7
Improved Feeder Hose Set-up

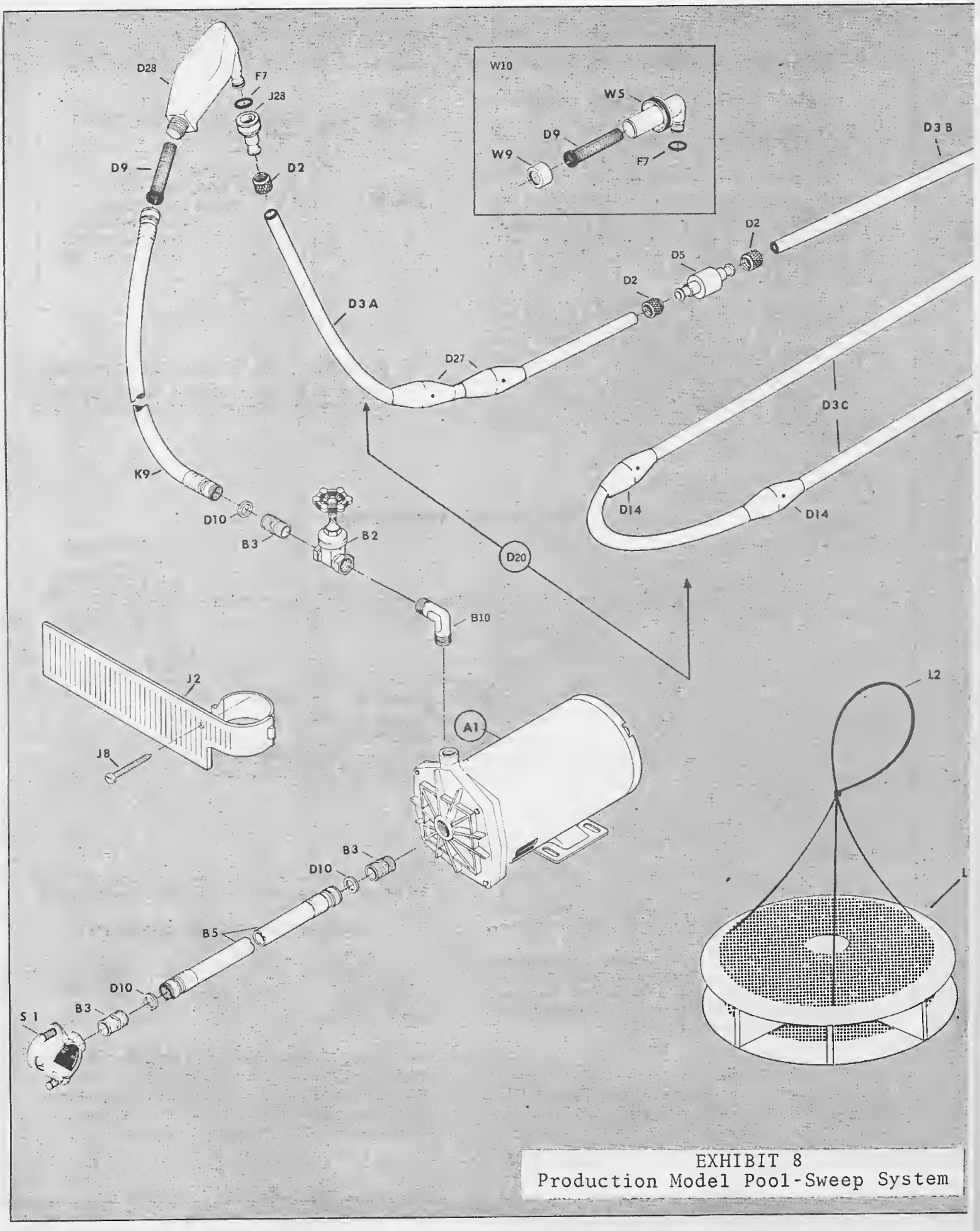
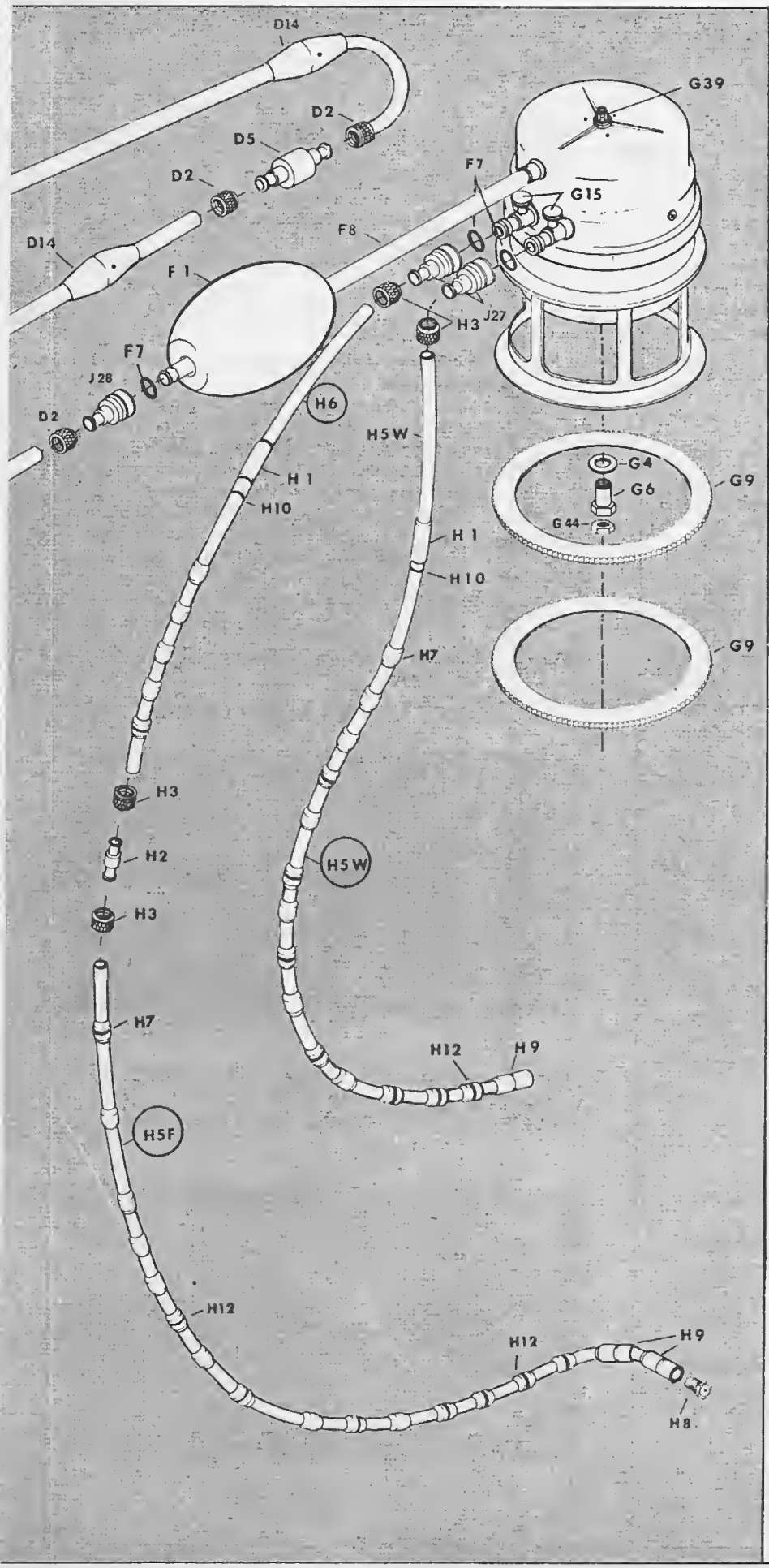


EXHIBIT 8
Production Model Pool-Sweep System



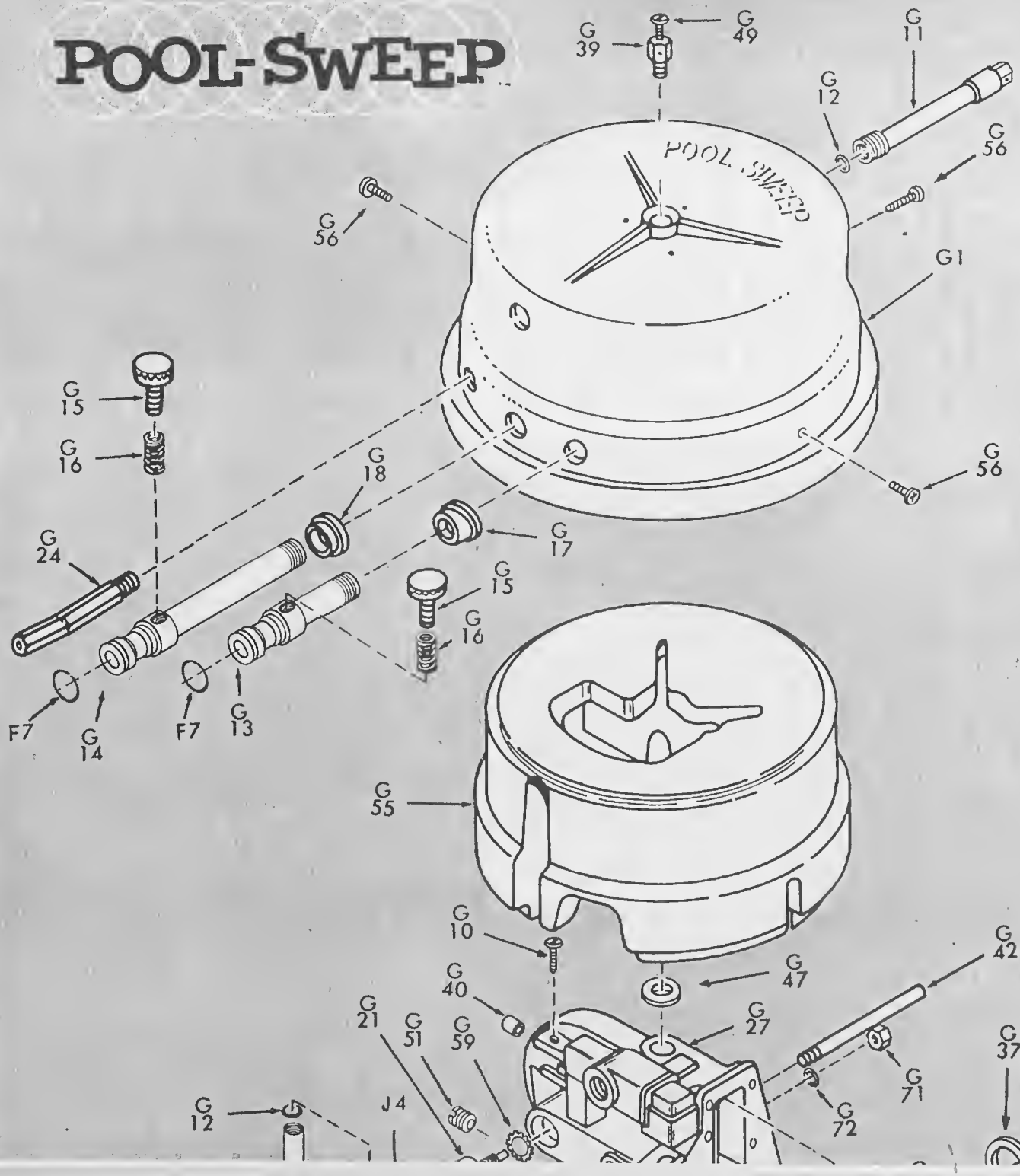
POOL-SWEEP

PARTS LIST

PART NO.	DESCRIPTION	QTY.
A1	Pump-Motor Assembly	1
B2	Gate Valve, ¾", Brass	1
B3	Hose Adapter, ¾" x ¾" male	3
B5	Suction Hose, ¾"	1
B10	Male Elbow, ¾" x 90 degrees	1
D2	Mender Nut, ⅝"	6
D3A	Feeder Hose, 6 ft. length	1
D3B	Feeder Hose, 10 ft. length	1
D3C	Feeder Hose, 16 ft. length	1
D5	Swivel Connector	2
D9	Screen	1
D10	Washer for ¾" hose	3
D14	Float, small	4
D20	Feeder hose, complete	1
D27	Weight for Feeder Hose	1
D28	Deck Stand, complete (for existing pool)	1
F1	Float, large	1
F7	"O"-ring, #014, ⅝" x 1/16"	4
F8	Float arm assembly	1
G4	Flat washer, 7/16" nickel-plated	1
G6	⅜" Housing Nut, nickel	1
G9	Housing Tire	2
G15	Thumb screw for sweep hose adjustment	2
G39	Tile Rinser Assembly	1
G44	Jam Nut, ⅜"—16 plated	1
H1	Hose weight	2
H2	Hose mender, 7/16"	1
H3	Mender Nut, 7/16"	4
H5W	Wall Sweep hose, 10 ft. length	1
H5F	Floor Sweep hose, 10 ft. length	1
H6	Floor hose extension, 8 ft. length	1
H7	Hose Sleeve without insert, Floor Hose	18
	Floor Hose Ext....8, Wall Hose	19
H8	Hose Jet	2
H9	Hose Jet Sleeve	3
H10	Stop ring for hose weight	2
H12	Hose Sleeve with metal insert	
	Floor Hose..13, Ext...1, Wall Hose	9
*J2	Ladder Guard (including screw, J8)	1
*J8	Self-tapping screw for ladder guard	1
J27	Quick-disconnect coupling for 7/16" hose	2
J28	Quick-disconnect coupling for ⅝" hose	2
K9	Supply Hose, ¾"	1
L1	Leaf Trap Assembly	1
L2	Harness for leaf trap	1
*S1	Saddle Tee (give size when ordering)	1
W5	Wall Fitting only, 1½" (for new pool)	1
W9	Screen retainer	1
W10	Wall Fitting, 1½", complete (including W5, D9, W9, F7)	1

*The Ladder Guard (J2 & J8) and the Saddle Clamp (S1) are not included with the Pool-Sweep.

POOL-SWEEP



HEAD PARTS LIST

PART NO.	DESCRIPTION	QTY.
F7	"O"-ring, #014, 5/8" DO x 1/16"W	2
G1	Top Shell	1
G3	Washer, 7/16" x 3/4", flat brass	1
G4	Washer, 7/16" x 3/4", flat plated	1
G5	Housing Nut, 3/8", brass	1
G6	Housing Nut, 3/8", plated	1
G9	Housing Tire	2
G10	Screw, 8 x 5/8" Pan Hd. "A" 18-8 S.S.	16
G11	Side Thrust Jet	1
G12	"O"-ring, #010, 3/8" DD x 1/16" CS	3
G13	Connector, Wall Hose, male	1
G14	Connector, Floor Hose, male	1
G15	Thumb Screw	2
G16	Compression Spring	2
G17	Grommet, Wall hose connector	1
G18	Grommet, Floor hose connector	1
G21	Valve body	1
G24	Orive jet	1
G26	Gear axle, complete	1
G27	Gear housing	1
G28	Cover, gear housing	1
G29	Gasket, gear housing cover	1
G30	Lower Bearing, gear housing axle	1
G31	Upper Bearing, gear housing axle	1
G32	"D"-ring, #123, 1-3/8" DD x 3/32" CS	1
G33	Turbine wheel	1
G34	Bearing, impeller end, plastic	1
G35	Bearing, impeller end, bronze	1
G36	Valve Gear, nylon	1
G37	Spacer, Valve gear	1
G39	Tile Rinser with screw	1
G40	Small Spacer, 1/4" x 1/4", brass	1
G41	Medium Housing Spacer, 1/4" x 1-15/16"	1
G42	Large Housing Spacer, 1/4" x 3-7/16"	1
G44	Jam Nut, 3/8"-16, plated	1
G47	Spinner Washer, 5/8", neoprene	1
G49	Tile Rinser Screw, 8-32 x 5/16" B.H.	1
G50	Bearing, Impeller trust 3/8" OD ball	1
G51	Plug, 7/16" x 3/8", brass	1
G55	Cleaner Float, inside head	1
G56	Screw, Housing Spacer 8-32 x 1/2" Phil. P.H.	3
G57	Washer, 3/16" x 1/2" DD brass	2
G58	Screw, bearing keeper, 8-3/8" S/T	2
G59	Washer, Valve lock, 5/16"	1
G67	Bottom Shell with Extension	1
G69	Gear Housing brace	1
G70	Machine Screw, 6-32 x 2-1/2", 18-8 SS.	1
G71	Hex Nut, 6-32, 18-8 S.S.	1
G72	#6, Reg. Lock Washer, 18-8 S.S.	1
J-4	"O"-ring, 3/4" DD x 1/16" W	1

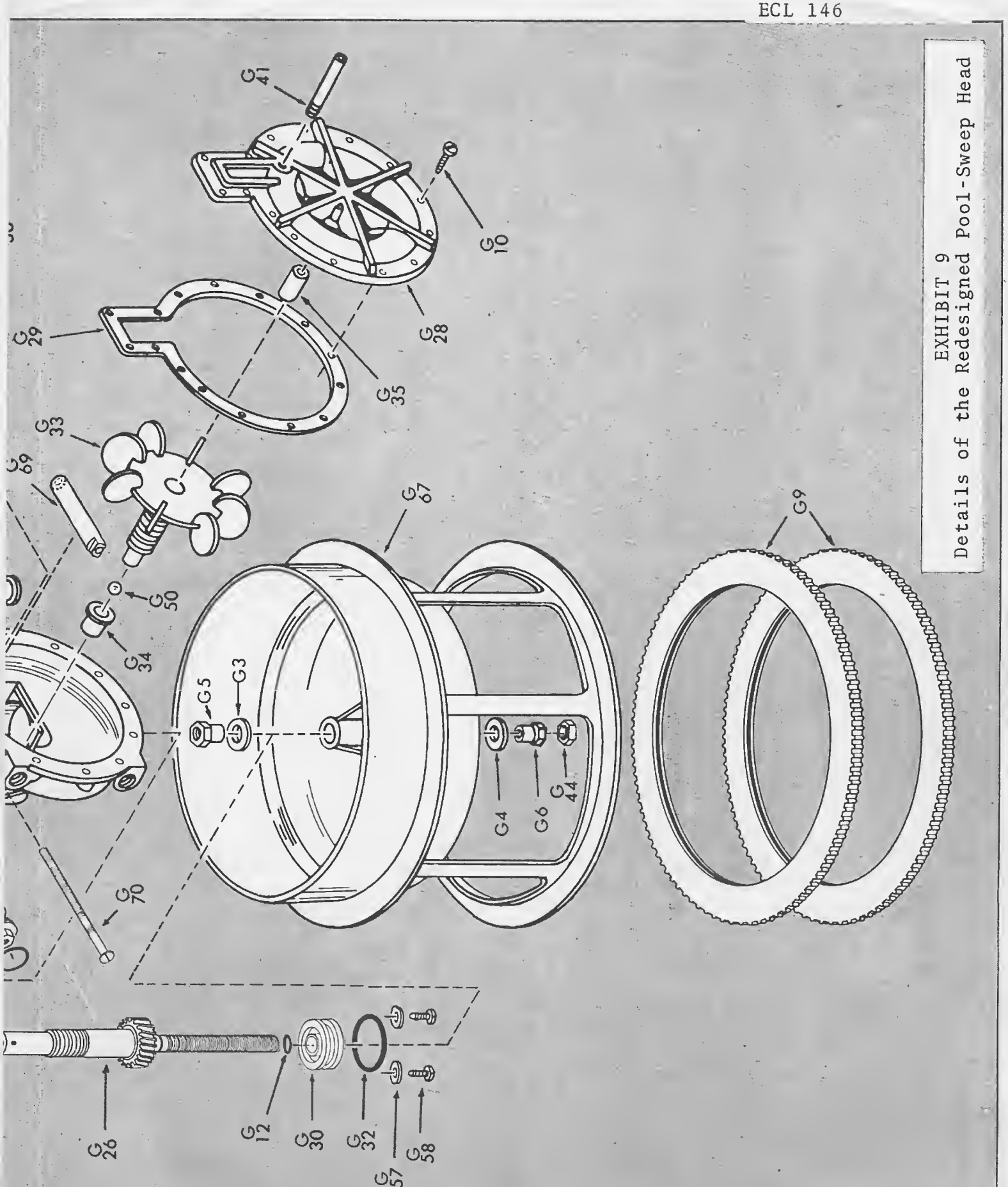


EXHIBIT 9
Details of the Redesigned Pool-Sweep Head